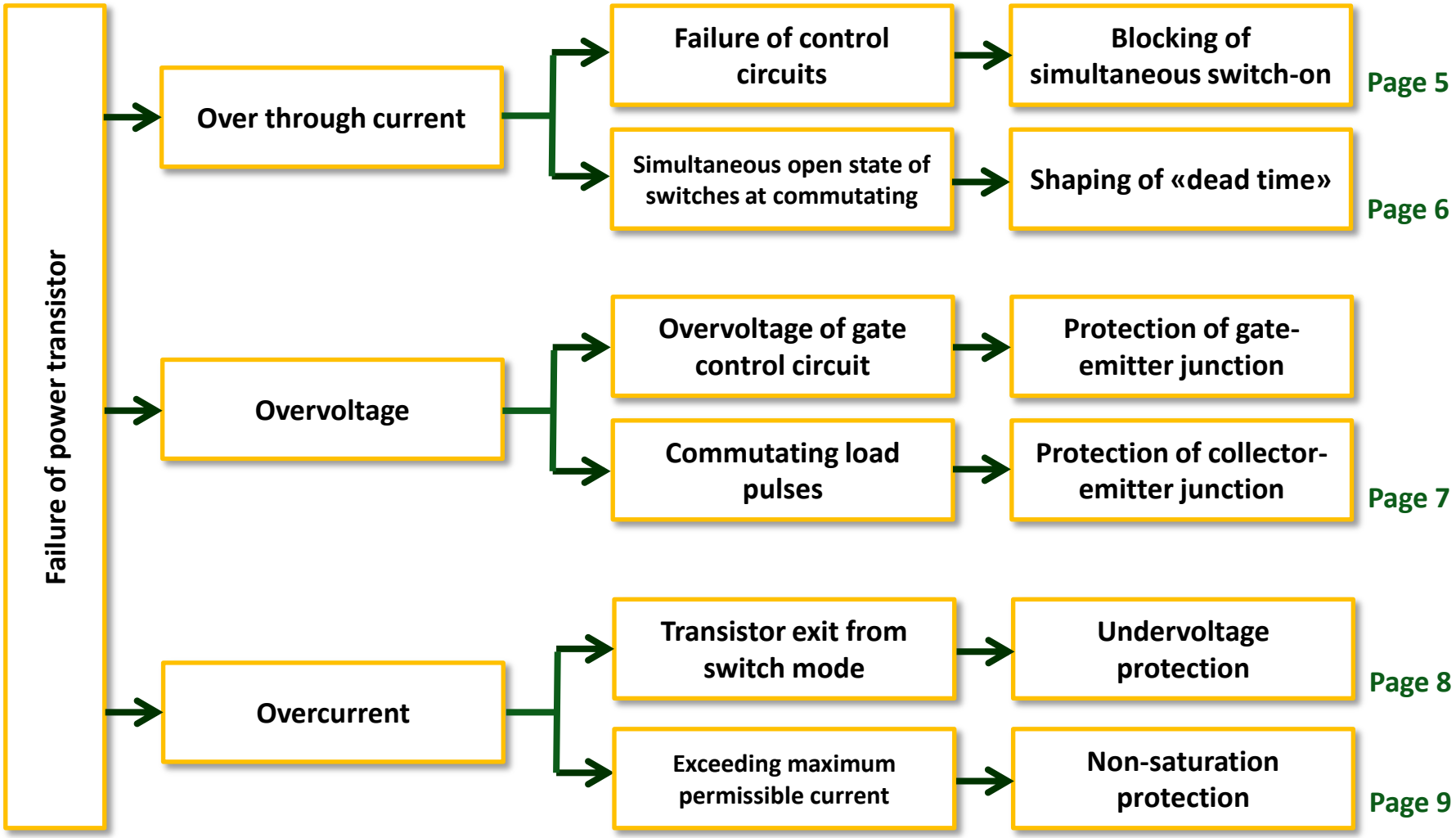
Drivers functioning of IGBT- and MOSFET-transistors

Causes of failure of power transistors



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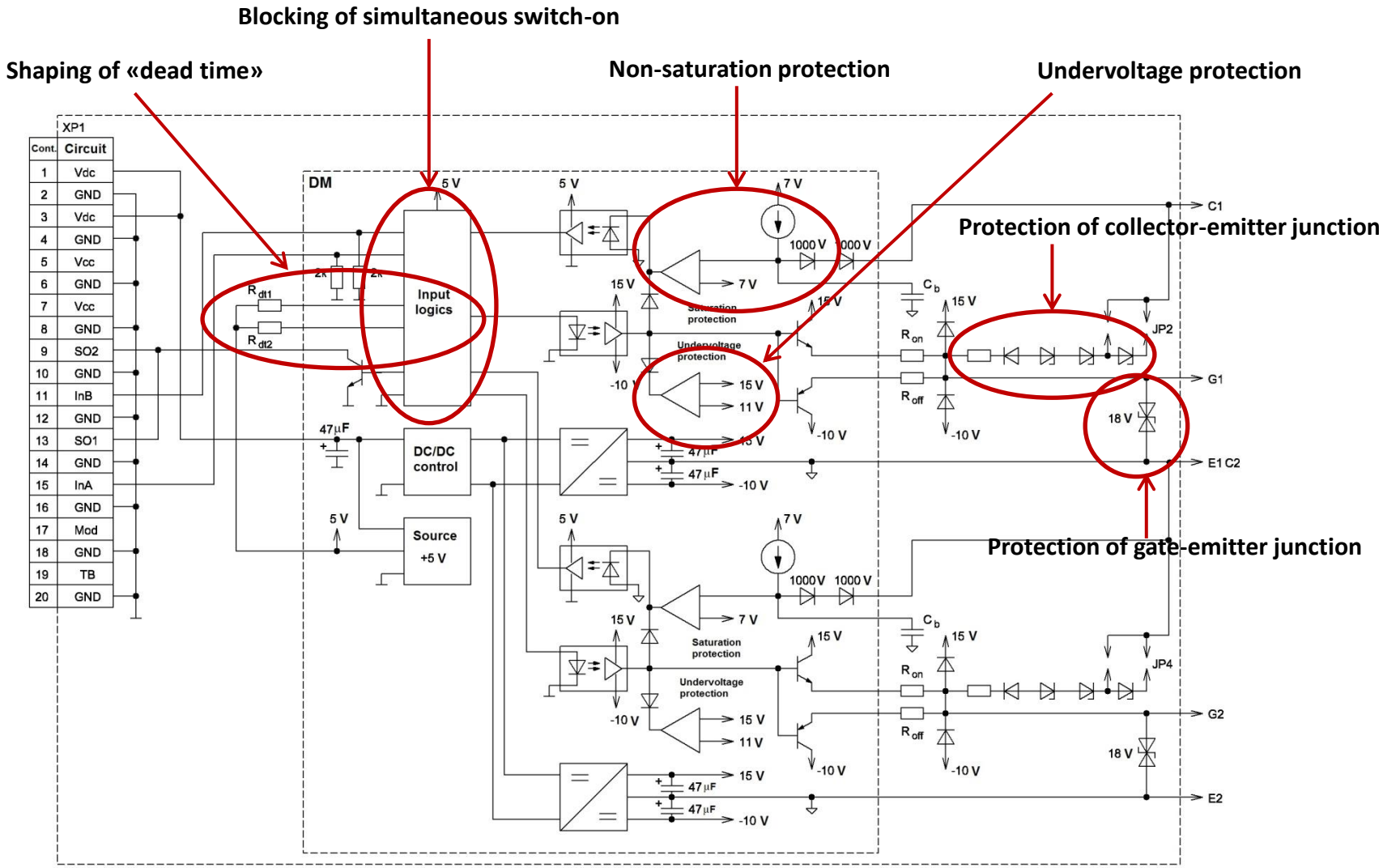
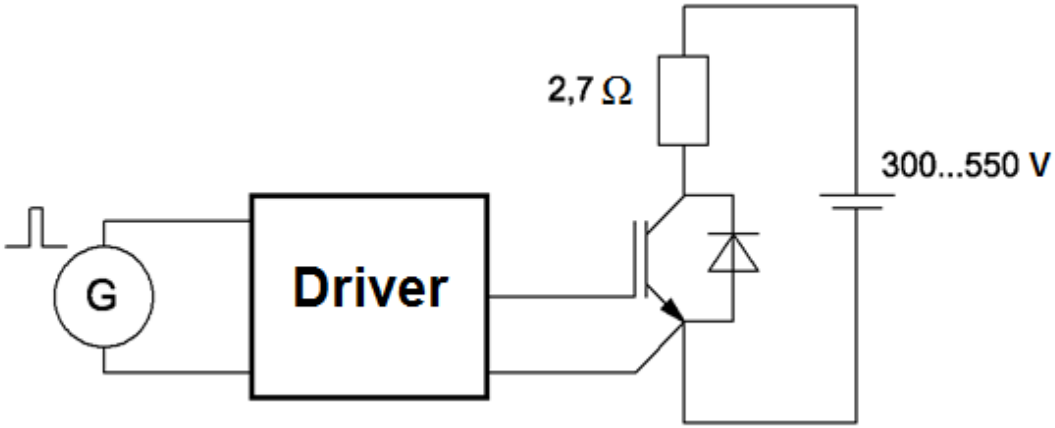
Typical structural circuit of driver using DR2180P-B3 (analogue of 2SP0320T) as an example



Test conditions



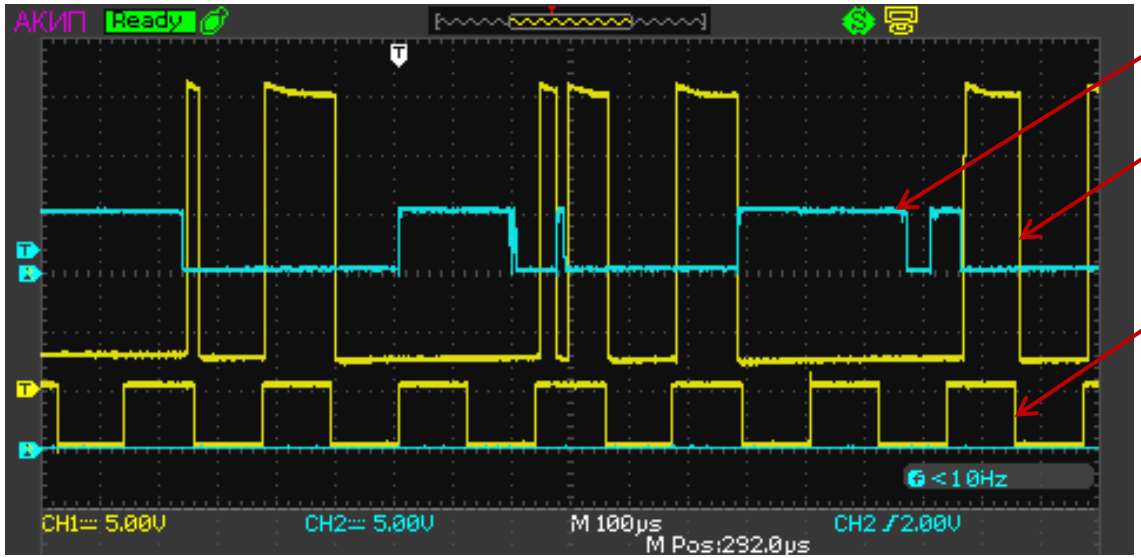
Driver – two-channel DR2180P-B3

Power IGBT-module of single switch
M9-100-12 (100 A / 1200 V)

Circuit of lower switch, active-inductive load
(2.7 or 1.8 Ω)

Logics tests of driver operation –
without load

Blocking of simultaneous switch-on



Input of channel 2

Output of channel 1

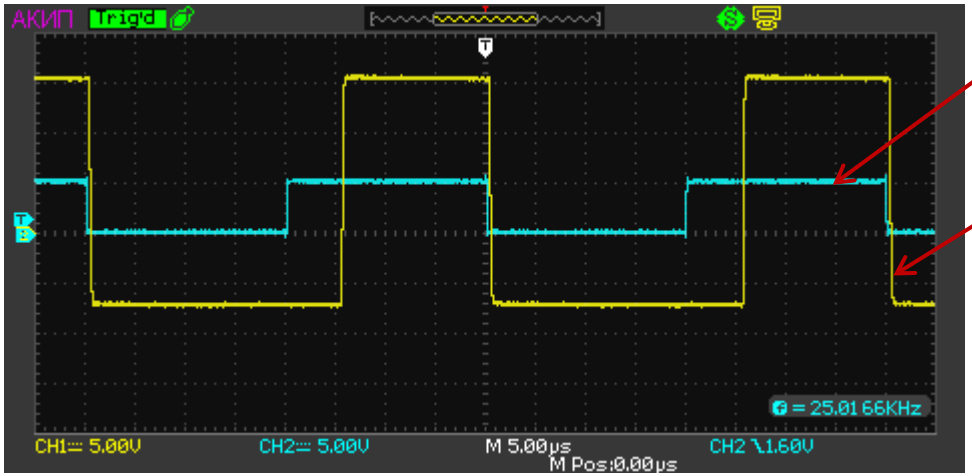
Input of channel 1

Blocking: output signal of channel 1 at its correct controlling and triggering of error input signal 2

Blocking of simultaneous switch-on of two drivers channels – this feature eliminates the through current in a controlled half-bridge with incorrect control.

The blocking involves forming closed states of two switches at simultaneous setting a signal of high level to control inputs of channel 1 and channel 2 (corresponds to open state of the switch).

Forming of «dead time» to switch



Input signal

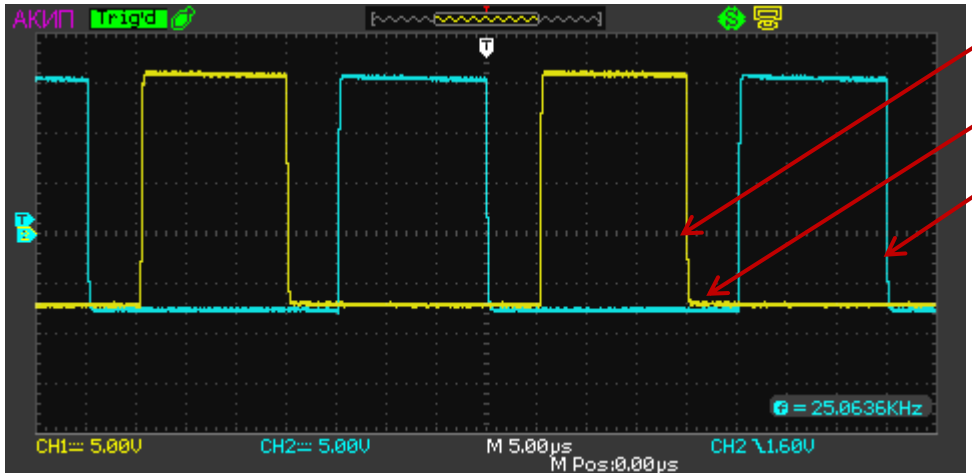
Output signal

Forming of switch-on delay

«Dead time» – this is an operating phase of half-bridge switches, in which both switches are in closed state.

«Dead time» is necessary to avoid through currents at switching the transistors.

«Dead time» is formed by creating an artificial switch-on delay because of (with respect to the input signal), at that delay for disabling does not increase.



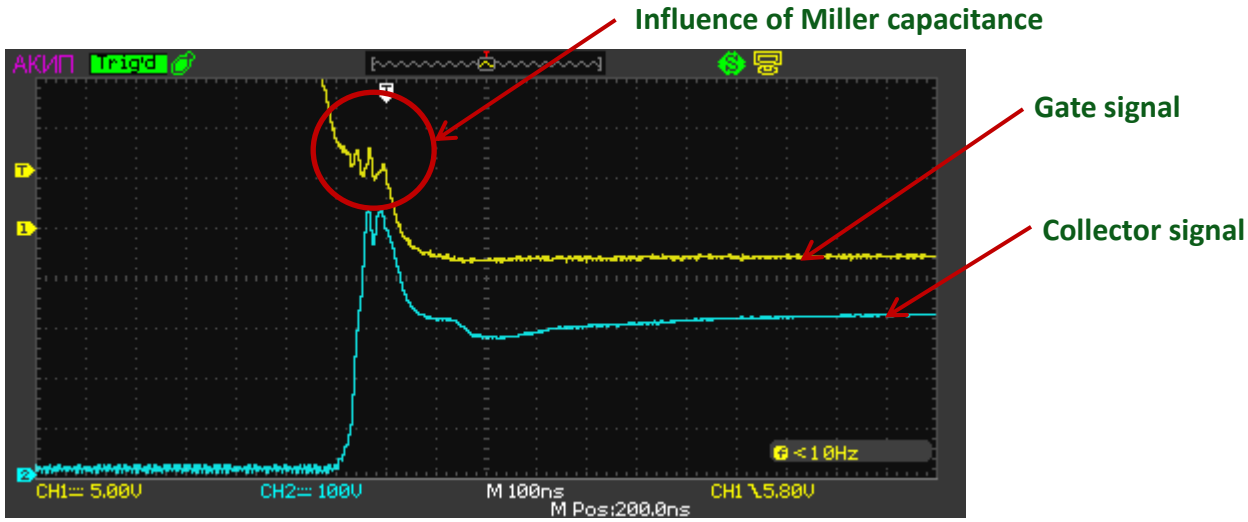
Output of channel 1

«Dead time»

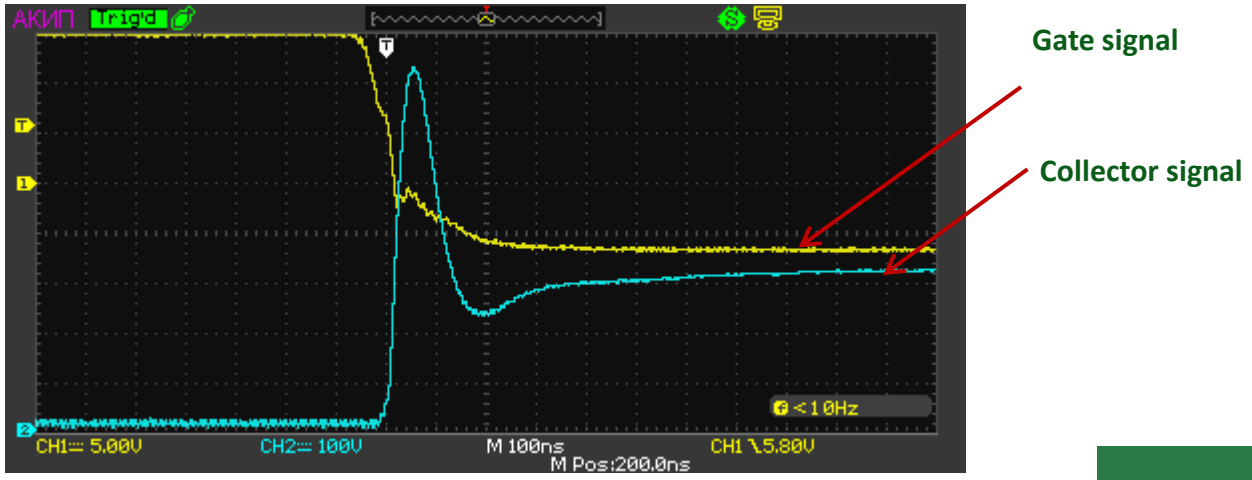
Output of channel 2

Output signals of two channels with «dead time»

Protection of collector-emitter junction against overvoltage during commutation



Switch-off with connected «active clamping»



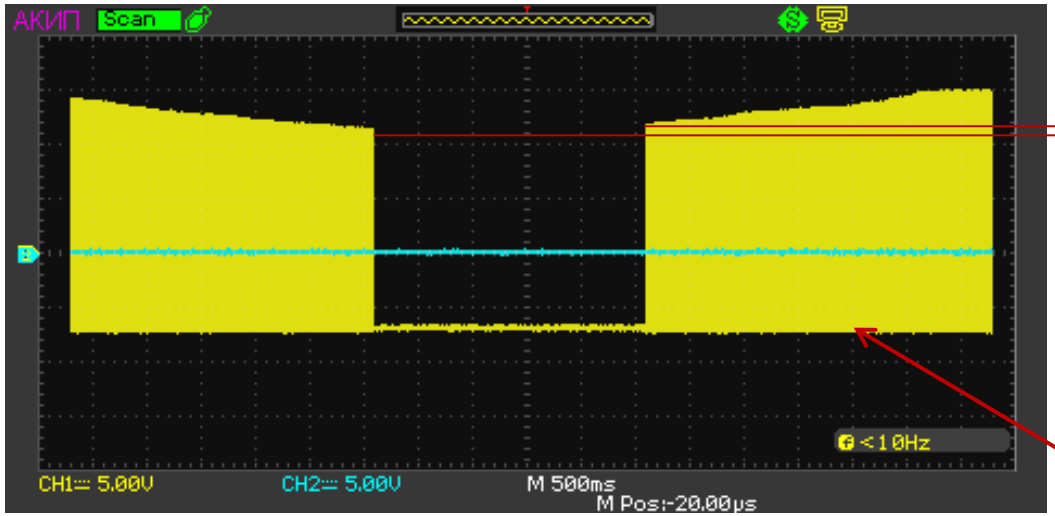
Switching off with disconnected «active clamping»

Reverse inductive surges in times of switching off can have a big amplitude and they can lay the transistor out.

To limit voltage surge amplitude used the function of «active clamping».

When the voltage exceeds protection circuit threshold voltage on the collector (in the example - 400 V), the voltage from the collector circuit recharges the Miller capacitance when you turn off, thereby opening up the transistor and increasing the duration of its switch-off.

Protection against barrier undervoltage in gate circuit



Switch-on threshold

Switch-off threshold

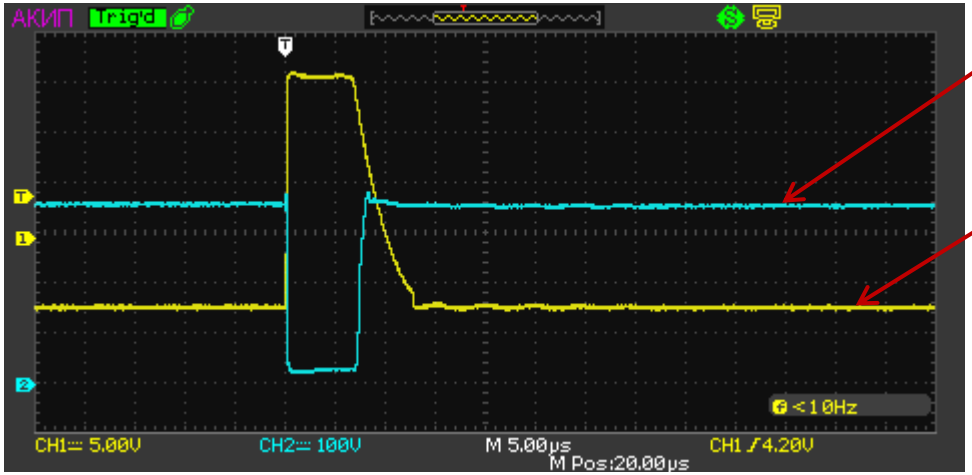
Gate signal

Output signal at decreasing and increasing of output supply voltage

Decrease of barrier voltage in the transistor gate can lead to its exit from the saturation state at a given current and a shifting of the operating point in the active area of the CVC, which leads to an increase in the voltage drop on the collector-emitter junction and as a result, overheating and failure.

To exclude occurrence of this failure mechanism, the driver blocks the control (DC blocking output voltage) at a decrease of supply voltage lower than the allowable threshold (11 V) and allows operating when the voltage excesses the threshold of 12 V.

Non-saturation protection

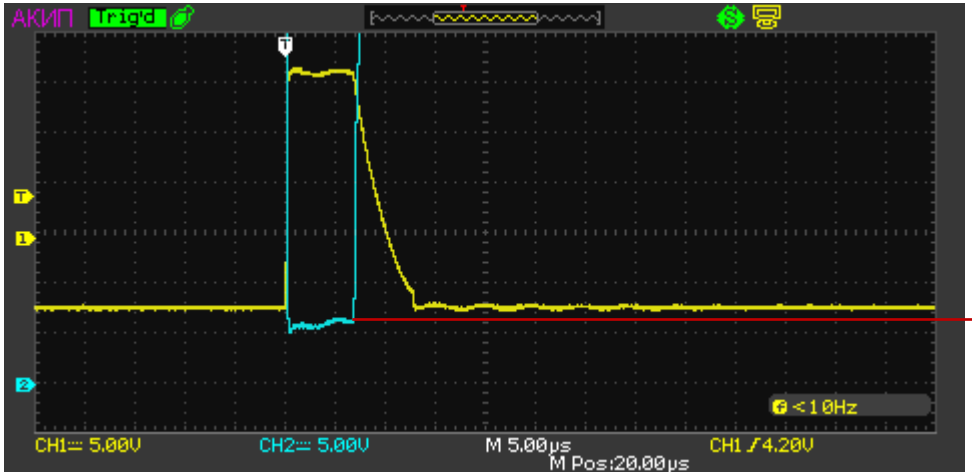


Pulse of «restart» of non-saturation protection

Increasing of the voltage fall on the collector-emitter junction when the load current exceeds the maximum permissible values leads to heating of the transistor and its failure.

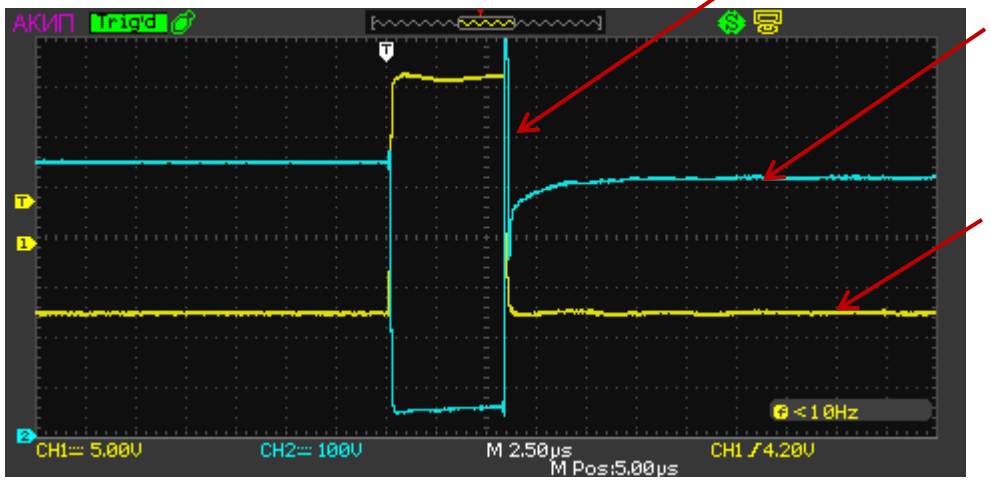
The driver controls collector-emitter voltage fall and switch on the transistor when voltage exceeds the standing threshold.

Thus, it can be provided the current protection (including against short-circuit in the load) of the controlled transistor.



Collector-emitter voltage fall at protection operating

Smooth switch-off when non-saturation protection operating

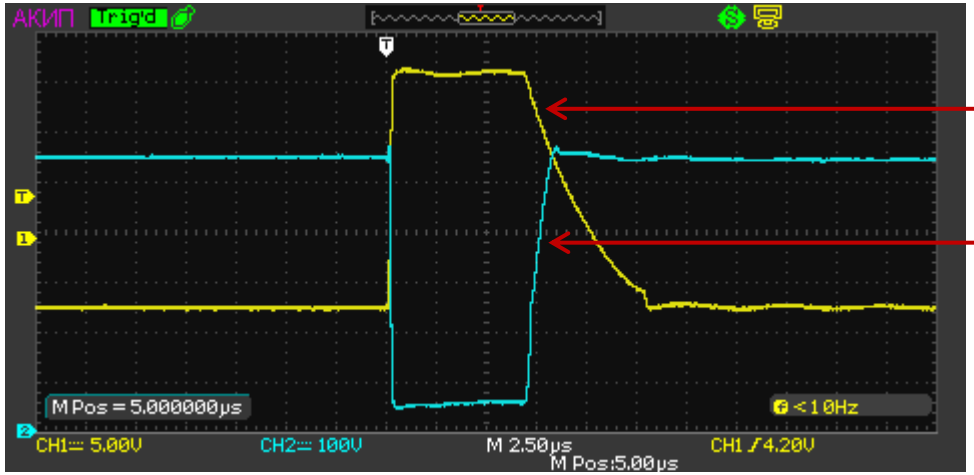


Transistor cutting off in overload conditions without smooth switching off

When switching off the transistor in the overcurrent mode it may occur an inductive surge that able to lay out the transistor.

To reduce the amplitude of the surge at the transistor cutting off, the driver creates smooth shutdown.

Thus, the smooth transistor switching off in the overcurrent mode is essential for its safe cutting off.



Transistor cutting off in overload conditions with smooth switching off

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